Scope and applicability

This manual applies to all personnel working at or visiting Arizona State University, hereafter known as ASU, who procure or utilize Class 3B and Class 4 lasers and laser systems.

Procurement and user of Class 1 and Class 2 laser equipment, such as laser pointers and compact disk players, do not usually need to comply with the manual's provisions. Any servicing, modification or other manipulation of Class 1 and Class 2 systems resulting in access to laser radiation from embedded Class 3 and Class 4 does fall within the scope of this manual. Under these conditions, the lasers must be registered, user-trained and appropriate control measures employed.

Chapter 1: Overview of Safety Requirements for Lasers

1.1 Registration

Class 3B and 4 lasers and laser systems must be registered with the Office of Radiation Safety. The registrant must be a full-time faculty or staff member at ASU who is responsible for safely using registered equipment. New equipment must be registered before operation. Class 3B and 4 lasers and laser systems brought to ASU must be registered with ORS, also.

1.2 Laser classification

Lasers at ASU must be classified in accordance with provisions of Chapter 3 of this document. Lasers purchased commercially may retain the classification provided by manufacturers in compliance with requirements of the Federal Laser Product Performance Standard, provided modifications altering the classification have not been made. Modified lasers, or lasers constructed on site, must be classified by the Laser Safety Officer.

1.3 Training

All individuals operating Class 3B and Class 4 lasers or laser systems must obtain training on the hazards associated with the equipment and proper safety control measures.

1.4 Safety control measures

Class 3B and Class 4 lasers or laser systems must be operated under administrative or engineering control measures approved by the Laser Safety Officer before operation. These measures might include written procedures for operation, maintenance (e.g., alignment) and/or laser servicing.

1.5 Laser surveys

Periodic safety surveys of lasers and laser control measures will be made by the Office of Radiation Safety or ORS.

1.6 Exemption of lower-class lasers

Lasers or laser systems not classified as 3B or 4 are exempt from all requirements of this manual. Class 3B or 4 lasers embedded within a device engineered to be of a lower class will require temporary control measures during maintenance and service if the higher-class laser emission becomes accessible.

Chapter 2: Laser Safety Organization at ASU

2.1 Arizona Radiation Regulatory Agency, AZ DHS-BRC

ASU procures and uses Lasers and Laser Systems under the regulations of AZ DHS-BRC. The regulations require that ASU personnel use AZ DHS-BRC-approved procedures to control all lasers. The agency also requires an accurate inventory of Class 3B and 4 lasers.

ASU is subject to inspection by AZ DHS-BRC. The agency can issue fines and even suspend or revoke laser use depending on the severity of non-compliance with their state regulations.

2.2 Radiation Safety Committee, RSC

ASU governs the use of lasers through the RSC. This committee is a group of faculty and staff appointed by the president of ASU to establish policies and regulations for the use of radiation sources and to oversee all aspects of radiation safety. The committee meets at least quarterly to review the university's radiation safety program.

2.3 Laser Safety Officer, LSO

A Laser Safety Officer — LSO — at ASU is appointed by EHS and must be acknowledged by the AZ DHS-BRC agency, which delegates specific responsibilities to the LSO. The LSO is granted the authority and responsibility to evaluate and control laser hazards, implement control measures, and monitor and enforce compliance with required standards and regulations. Wherever duties and responsibilities of the LSO are specified, it will mean that the LSO either performs the stated task or ensures a qualified individual performs the task. Such duties and tasks include the following:

2.3.1 Classification

The LSO will classify or verify classifications of lasers and laser systems used at ASU.

2.3.2 Hazard evaluation

The LSO is responsible for the hazard evaluation of laser work areas.

2.3.3 Control measures

The LSO is responsible for assuring that the prescribed control measures are in effect, recommending or approving substitute or alternate control measures when the primary ones are not feasible or practical, and periodically auditing the status of those control measures in use.

2.3.4 Procedure approvals

The LSO approves standard operating procedures, alignment procedures and other procedures that may be part of the requirements for administrative and procedural control measures.

2.3.5 Protective equipment

The LSO recommends and approves protective equipment, i.e., eyewear, clothing, barriers, screens, etc., as may be required to assure personnel safety. The LSO ensures that protective equipment is audited periodically to ensure proper working order.

2.3.6 Signs and labels

The LSO approves the wording on area signs and equipment labels.

2.3.7 Facility and equipment

The LSO approves laser installation facilities and laser equipment before use. This also applies to the modification of existing facilities or equipment.

2.3.8 Authority

The LSO has the authority to suspend, restrict, or terminate the operation of a laser or laser system if they deem that laser hazard controls are inadequate. The actions of the LSO are reviewed by the RSC.

2.4 Registrant

Each Class 3B or Class 4 laser or laser system at ASU must be registered with the laser safety officer at EHS. Each laser or laser system must be registered to a faculty or staff member of ASU who maintains responsibility for all aspects of laser safety for the registered equipment. Specific responsibility of the registrant includes:

2.4.1 Registration

The registrant must register new equipment with the LSO within 30 days of receipt and before the operation of new laser equipment.

2.4.2 Permit procedures

The registrant must ensure the Laser Control Area Permit is completed for all laser personnel and incidental personnel before authorized entry. The registrant must ensure personnel with access to a laser-controlled area — LCA — complete the EHS Laser Safety Training Class and onsite training by a qualified person. The registrant must keep a record of these training records.

The registrant must submit proposed operating and alignment procedures and hazard control measures to the LSO for approval before the operation of new devices or after modification of existing laser or laser systems.

2.4.3 Training

The registrant must ensure that all personnel who have access to the laser-controlled area, including operators of laser equipment, are properly trained for safe operation and made aware of laser hazards associated with the laser equipment as applicable.

2.4.4 Eye exam

Baseline eye exams are no longer required as of the ANSI Z136.1 – 2007 version of the user standard. Medical examinations shall be performed as soon as practical, usually within 48 hours, when a suspected injury or adverse biological effect from a laser exposure occurs.

Chapter 3: Laser and Laser System Classification

3.1 Laser classification

Lasers and laser systems are classified by their ability to cause biological damage to the eye or skin during use. Purchased lasers are labeled and classed by manufacturers to comply with the requirements of the Federal Laser Product Performance Standard. Lasers that are modified in ways that may change the classification provided by the manufacturer must be reclassified by the Laser Safety Officer.

3.1.1 Class 1 lasers

Lasers or laser systems incapable of producing damaging radiation during intended use are Class 1 lasers. These lasers are exempt from any controls or administrative requirements during normal use. However, most Class 1 laser systems contain embedded lasers of a higher class. Alignment and service procedures for embedded Class 2, 3, or 4 lasers require appropriate control and administrative procedures appropriate to the class during these functions. Class 1 limits could be exceeded if magnifying optics are used. The LSO should be contacted to assess.

3.1.2 Class 2 lasers

Class 2 lasers — low power— are lasers emitting radiation in the visible portion of the spectrum. Even though the power of these lasers is such that they will normally be protected by a physiological aversion response, such as blink reflex, personnel should wear laser eyewear for protection. The class 2 maximum permissible exposure limits can be exceeded if the beam is viewed directly for extended periods or if magnifying optics are used. The LSO should be contacted to assess.

3.1.3 Class 3 lasers

Class 3 lasers and medium-power laser systems produce radiation that can cause eye damage when viewed directly or when a specular reflection is viewed. A diffuse reflection is usually not a hazard. Class 3a and 3R lasers do not have the same control measures as Class 3B lasers and are higher under most conditions.

3.1.4 Class 4 lasers

Class 4 lasers and high-power laser systems produce radiation that may be dangerous to the eye even when viewing a diffuse reflection. The direct beam can produce skin damage and can also be a fire hazard. Laser-generated air contaminants — LGACs — are also possible.

3.2 Embedded lasers

Many laser systems contain embedded lasers, which are more hazardous or of a higher class than the system. Alignment or service procedures for embedded lasers must be conducted in accordance with requirements appropriate for the class of the embedded laser.

3.3 Classification by the Laser Safety Officer — LSO

Lasers or laser systems that are modified in ways that may alter the hazard of the emitted radiation must be reclassified by the LSO. The reclassification will usually be from a lower to a higher class, although modifications of laser systems that provide additional safety features may result in a lower classification.

3.4 Multi-wavelength lasers

Laser classification will be based on the most hazardous possible configuration for a multi-wavelength laser or laser system.

Chapter 4: Registration for Lasers and Application for Permits

4.1 Registration of lasers

All Class 3B and 4 lasers at ASU must be registered with the Office of Radiation Safety. In general, registrants must be full-time faculty or staff of ASU. Lasers obtained from other sources, such as salvage, government loans or other universities, must be registered.

4.1.1 Registration

Lasers are registered by submitting the appropriate form to the LSO. Registration forms will be sent to the Principal Investigator — PI — by ORS.

4.1.2 Responsibility of ASU registered laser user — Principal Investigator

Responsibilities of registrants include:

1. Registering all laser personnel and incidental personnel with ORS.
2. Ensuring that operators are properly trained.
3. Ensuring that ASU and AZ DHS-BRC-approved control measures are used for Class 3B and 4 lasers.
4. Notifying the LSO before modifications to lasers, changes in procedures and changes in control measures
5. Notifying the LSO of any changes in the status and location of Class 3B and 4 lasers.

Chapter 5: Laser Hazard Control Requirements

5.1 Overview of hazard controls

In general, the following control measures are required for Class 3B and 4 lasers:

1. Access restrictions, including key master switch, interlocked entry or beam enclosure.
2. Training of operators and personnel working who have access to the laser control area.
3. Posting and labeling of rooms and equipment, including a warning light in the hallway (Class 4 only) or access entrance.
4. Protective eyewear and clothing.
5. Engineering controls such as beam stops, curtains and enclosures.
6. LSO review and approval of laser safety SOPs.

The exact combination of these control measures depends on the power and type of laser, laser environment, and procedures conducted with laser equipment. The LSO approves control measures before the operation of lasers.

5.2 Access restrictions

5.2.1 Master switch

Class 3B and 4 lasers must have a master switch that is controlled by a key or coded access. Access by key or code must only be provided to trained operators and other personnel approved by the LSO. Exceptions to this requirement may be approved by the LSO, provided other engineering and administrative controls are used to prevent unauthorized use of laser equipment.

5.2.2 Interlocked entry

Entry to rooms containing Class 4 lasers and laser systems must be interlocked OR secured by ISAACS with the laser to prevent the unexpected entry of personnel while the laser is in operation. The secured doors must be engineered such that:

1. Rapid egress is always allowed, and admittance to the laser area is allowed under emergency conditions.
2. For emergency conditions, a control disconnect switch, panic button or equivalent device must be available for deactivating the laser.
3. During continuous operation of a laser, the individual in charge of the interlocked room may momentarily override the safety interlocks to allow access to other authorized personnel if it is clearly evident that there is no optical radiation hazard at the point of entry and if the necessary protective devices are being worn by the entering personnel.

Note: Exceptions to these requirements may be approved by the Radiation Safety Committee, provided that alternate engineering and administrative controls are used to prevent the unexpected entry of personnel into a hazardous area during laser operations.

5.2.3 Exceptions for lasers utilizing beam enclosure

In applications of laser or laser systems where the entire beam path is enclosed, certain access restrictions are not needed. See sections 5.8 and 5.9.

5.3 Training of operators and personnel working on or near lasers

5.3.1 Training

Training shall be provided to each employee working with or around lasers of Class 3B or 4. Laser training must be provided by the LSO or a designated representative.

Training must cover the following topics:

1. Fundamentals of laser operation, including the physical principles and construction.
2. Biological effects of laser radiation on the eye and skin.
3. Relations of specular and diffuse reflections.
4. Non-radiation hazards of lasers:

    a. Chemical.
    b. Electrical.
    c. Reaction by products.

5. Laser and laser system classifications.
6. Control measures.
7. Overall management and employee responsibilities.
8. Medical Surveillance.

The LSO or a designated representative must provide the ORS laser safety class for general safety training purposes. Operators must obtain onsite training with the laser system from the registrant or registrant representative.

5.4 Posting and labeling of rooms and equipment

5.4.1 Equipment labels

All classes of lasers or laser systems, except for Class I, are required to contain warning labels by the Federal Laser Product Performance Standard. Manufacturers place these labels on laser equipment. These labels must not be removed. Equipment modified or constructed at ASU shall be provided with labels that are clearly visible during operation and affixed to the laser housing or control panel. Labels must be placed on both laser housing and control panel when these are separated by more than 2 meters. Label design and verbiage are provided by the LSO.

5.4.2 Posting of rooms

Areas containing Class 3B or 4 lasers must be posted with appropriate signs. The design and verbiage of the sign must be approved by the LSO.

5.5 Protective eyewear and clothing

5.5.1 Eye protection devices

Eye protection devices specially designed for protection against radiation from lasers must be used by all personnel working with or near lasers during laser operation unless engineering, procedural, or administrative controls are used to eliminate likely exposure.

All protective eyewear must be clearly labeled with the optical density and wavelength for which protection is afforded.

In addition, eyewear should be marked with a unique identifying label that will assist in maintaining inspection and inventory records required by AZ DHS-BRC regulations.

Lab personnel must inspect and document eyewear twice a year. Eyewear will be inspected by ORS staff during semiannual laser inspections. Inspection records will be reviewed. Protective eyewear will be removed from service if damaged or otherwise unable to provide protection adequate for the laser equipment in use. For laser eyewear, the ORS has a list of vendors' and registrants' inventory.

5.5.2 Protective clothing

Protective clothing is required when personnel may be exposed to radiation that may damage the skin. The LSO determines the need for protective clothing and the type of clothing to be used.

5.6 Engineering Controls

5.6.1 Beam enclosures

Beam enclosures should be used whenever practical. The use of enclosures will significantly reduce the need for other engineering or administrative controls; see Sections 5.8 and 5.9.

5.6.4 Window and door barriers

All windows, doorways, open portals, etc., must be either controlled or restricted in such a manner as to prevent the escape of potentially hazardous radiation. Typically curtains at doorways are required for Class 3B and 4 lasers in open beam configurations to prevent the escape of potentially hazardous radiation. The ORS has a list of suitable barriers and curtain sources.

5.7 Administrative controls

5.7.1 Standard operating procedures

Written procedures shall be established for the operation, alignment, and maintenance of lasers at ASU. The LSO will require these procedures as part of the approved control measures.

5.7.2 Alignment procedures

Alignment of laser optical systems, including mirrors, lenses and beam deflectors, must be performed so that the primary beam, or a specular or diffuse reflection of a beam, does not expose the eye to dangerous levels of radiation.

Written procedures outlining alignment methods may be required. The use of low-power Class 1 or Class 2 visible lasers for path simulation of higher-power lasers is recommended for alignment of higher-power Class 3B and Class 4 visible or invisible lasers and laser systems.

Experience has shown that a significant ocular hazard may exist during alignment procedures.

5.7.3 Visitors and spectators

Spectators shall not be permitted within a laser area during the operation of a Class 3B or Class 4 laser or laser system unless:

1. Specific protective measures for visitors and spectators have been approved by the LSO.
2. The degree of hazard and avoidance procedure has been explained to spectators.
3. Appropriate protective measures are taken.

The ORS can help registrants ensure visitors obtain adequate protection.

5.7.4 Servicing of lasers

Personnel who require access to Class 3B or Class 4 lasers or laser systems contained within protective housing or protected area enclosure for the purpose of service must comply with the appropriate control measures of the enclosed or embedded laser or laser system. The service personnel shall have the education and training commensurate with the class of the laser or laser system contained within the protective housing. Third-party service personnel must be registered with the AZ DHS-BRC for such service, provide proof of the registration to the LSO before service, and have a written safety plan available upon request from the LSO before service.

5.7.5 Modifications of lasers or laser systems

The registrant **must notify the LSO** of any modifications that could change a laser's class and affects its output power or operator characteristics to make it potentially more hazardous. The LSO must review the control measures to determine if additional requirements are needed.

5.8 Exceptions for lasers with fully enclosed and interlocked beam paths

In applications of lasers or laser systems where the entire beam path is enclosed, the requirements for Class 1 laser systems are met, and none of the other control measures of this chapter are required, provided:

1. Interlocks are designed to prevent access to laser radiation. The interlock may be electrically or mechanically interfaced to a shutter or the power supply so that the beam is interrupted when the protective beam enclosure is opened or removed. These interlocks must be of fail-safe design.
2. The protective housing interlocks must not be defeated during operation.
3. Adjustments or procedures during service must not cause the interlocks to be inoperative when equipment is returned to normal operating conditions.
4. When requirements 5.1.1. through 5.1.3. are temporarily relaxed, such as during service, LSO-approved control measures must be applied. These may include temporary area control and administrative and procedural controls.

5.9 Exceptions for lasers with fully enclosed beam paths without interlocks

In the application of lasers or laser systems where the entire beam path is enclosed, but the enclosure does not meet the requirements specified in 5.8., the laser is exempt from controls described in Sections 5.2.2, 5.5.1., 5.5.2., and 5.6.4. provided:

1. Beam enclosures prevent access to laser radiation.
2. Beam enclosures are not removed during normal operation.

Chapter 6: Emergency Procedures

6.1 Emergency Procedures

The Office of Radiation Safety must be notified immediately of any incident involving known or suspected exposure to laser radiation.

During office hours, call the ORS at extension **965-6140**. During non-office hours, call ASU DPS dispatch at extension **965-3456** or dial **911**.